

PATENT APPLICATION

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

Appellant(s): Bai et al.

Examiner: Raymond, Brittany L

Serial No: 10/802,150

Group: Art Unit 1795

Filed: March 17, 2004

Docket: 8021-215 (SS-19582-US)

**For: ETCHING PROCESS INCLUDING PLASMA PRETREATMENT FOR
GENERATING FLUORINE-FREE CARBON-CONTAINING POLYMER ON A
PHOTORESIST PATTERN**

APPEAL BRIEF

Appeal from Group 1795

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I. INTRODUCTION

This Appeal is from a Final Office Action mailed on February 12, 2008 (hereinafter, referred to as the “Final Action”) finally rejecting claims 1-3, 5-17, 19-21, 23 and 24 of the above-identified application, and an Advisory Action mailed on May 6, 2008. Appellants commenced this Appeal by a Notice of Appeal dated June 12, 2008. The Notice of Appeal was filed with a Pre-Appeal Brief Request For Review. A Notice of Decision from Pre-Appeal Brief Review was mailed on July 1, 2008. The Notice of Panel Decision states that the application remains under appeal and should proceed to the Board of Patent Appeals and Interferences. Accordingly, Appellants hereby submit this Appeal Brief.

II. REAL PARTY IN INTEREST

The real party in interest for the above-identified application is Samsung Electronics, Co. Ltd., the assignee of the entire right, title and interest in and to the subject application by virtue of an assignment recorded in the U.S. Patent and Trademark Office at reel 015114 frame 0075.

III. RELATED APPEALS AND INTERFERENCES

There are no Appeals or Interferences known to Appellants, Appellants’ representatives or the Assignee, which would directly affect or be indirectly affected by or have a bearing on the Board’s decision in the pending Appeal.

IV. STATUS OF CLAIMS

Claims 1-3, 5-17, 19-21 and 23-24 are pending and are under appeal. Claims 1-3, 5-17, 19-21 and 23-24 have been rejected. The claims on appeal are set forth in the attached Appendix.

Claims 1, 9, 12, 15 and 21 are independent claims. Claims 2, 3 and 5-7 directly depend from claim 1 and claim 8 indirectly depends from claim 1, claims 10 and 11 directly depend from claim 9, claims 13 and 14 directly depend from claim 12, claims 16, 17 and 19 directly depend from claim 15 and claim 20 indirectly depends from claim 15, and claims 23 and 24 directly depend from claim 21.

V. STATUS OF AMENDMENTS

Claims 1, 9, 12, 15 and 21 were amended and claims 4, 18, 22 and 25 were canceled by the Amendment under 37 C.F.R. § 1.111, filed April 16, 2007. This Amendment was entered.

A Response to the Final Office Action was filed on August 22, 2007. The Response included no amendments. This Response was entered.

Claims 1, 9, 12, 15 and 21 were amended by the Amendment under 37 C.F.R. § 1.111, filed November 28, 2007. This Amendment was entered.

A Response to the Final Office Action was filed on April 11, 2008. The Response included no amendments. This Response was entered.

A Pre-Appeal Brief Request For Review was filed on June 12, 2008.

VI. SUMMARY OF THE CLAIMED SUBJECT MATTER

In general, the claimed subject matter relates to an etching process including plasma pretreatment for generating a polymer layer formed of carbon on a photoresist pattern. The

photoresist pattern is treated with plasma that does not contain fluorine radicals and that provides carbon radicals. An etching process is performed on an etching target layer by using the photoresist pattern as an etch mask.

A. Embodiments Of Claims 1, 9, 12, 15 and 21

Claims 1, 9, and 15 recite, *inter alia*, an etching method comprising treating the photoresist pattern comprising an ArF photoresist material with plasma generated by exciting a fluorine-free carbon-containing gas.

Claim 12 recites, *inter alia*, an etching method comprising forming a polymer layer comprising carbon on the surface of the photoresist pattern comprising an ArF photoresist material using plasma generated by exciting a fluorine-free carbon containing gas.

Claim 21 recites, *inter alia*, an etching method comprising forming a polymer layer using plasma generated by exciting a fluorine-free carbon-containing gas, the polymer containing carbon on the surface of the photoresist pattern comprising an ArF photoresist material.

For purposes of illustration, the embodiments of claims 1, 9, 12, 15 and 21 will be discussed hereafter with reference to the embodiment depicted in FIGS. 3 through 6 and the descriptions in Appellants' specification as cited below. It is to be understood that the following description of the claimed embodiments and reference to the drawings are for illustrative purposes to provide some context for the claimed embodiments, but nothing herein shall be construed as placing any limitation on the claimed embodiments.

More specifically, by way of example, FIGS. 3 and 4 show a formation of a photoresist pattern 230' wherein the surface of the photoresist pattern 230' is treated with carbon plasma to

form a polymer layer 250 on the photoresist pattern 230'. Further, by way of example, referring to FIGS. 3 and 4, the carbon plasma may be generated by exciting a fluorine-free gas that provides carbon, e.g., carbon monoxide (CO) or carbon dioxide (CO₂). See ¶ [0045] of the published present application. In addition, by way of example, FIGS. 5 and 6 show the selective etching of the etching target layer 210 wherein an exposed portion of the etching target layer 210 is selectively etched by using the photoresist pattern 230' as an etch mask. See ¶ [0049] of the published present application. An etchant used in the etching process may contain a fluorocarbon gas, for example, ChxFy or CxFy, which is excited to generate plasma. See ¶ [0050] of the published present application. In the etching process, the plasma provides fluorine radicals to the etching target layer 210 formed of, for example, silicon oxide, such that the fluorine radicals react on the silicon oxide. See ¶ [0051] of the published present application.

VII. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

- (1) Claims 1, 2, 5, 6, 9, 10, 12, 13, 15-17, 21 and 23 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Chu (US 2004/0192058) in view of Ma (US6830877).
- (2) Claims 1, 2, 5-10, 12, 13, 15-17, 19-21 and 23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Lindley (US 6326307) in view of Meyer (US 4504574) and Ma (US 6830877).
- (3) Claims 3, 11, 14 and 24 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Lindley (US 6326307) in view of Meyer (US 4504574) and Ma (US 6830877) and further in view of Ko (US 2003/0129816).

VIII. ARGUMENT

A. Rejections Under 35 U.S.C. § 103

In rejecting claims under 35 U.S.C. § 103, the Examiner bears the initial burden of presenting a *prima facie* case of obviousness. In re Rijckaert, 9 F.3d 1531, 1532 (Fed. Cir. 1993).

The burden of presenting a *prima facie* case of obviousness is only satisfied by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. In re Fine, 837 F.2d 1071, 1074 (Fed. Cir. 1988). A *prima facie* case of obviousness is established when the teachings of the prior art itself would appear to have suggested the claimed subject matter to one of ordinary skill in the art. In re Bell, 991 F.2d 781, 782 (Fed. Cir. 1993).

When obviousness is based on a single prior art reference, there must be a showing of a suggestion or motivation to modify the teachings of that reference. In re Kotzab, 217 F.3d 1365, 1370, 55 USPQ2d 1313, 1316-17 (Fed. Cir. 2000). The use of hindsight knowledge derived from the Appellants' disclosure to support an obviousness rejection under 35 U.S.C. § 103 is impermissible. See W.L. Gore and Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 1553, 220 U.S.P.Q. 303, 312-13 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984). Thus, if the Examiner fails to establish a *prima facie* case, the rejection is improper and must be overturned. In re Rijckaert, 9 F.3d at 1532 (citing In re Fine, 837 F.2d at 1074).

Appellants respectfully submit that claims 1, 2, 5, 6, 9, 10, 12, 13, 15-17, 21 and 23 stand rejected under 35 U.S.C. § 103(a) are patentable over Chu in view of Ma. For the reasons set forth below, Appellants respectfully request that the claim rejections under 35 U.S.C. § 103 be reversed.

1. Rejection of claims 1, 2, 5, 6, 9, 10, 12, 13, 15-17, 21 and 23 under 35 U.S.C. §103(a) as being unpatentable over Chu in view of Ma

- a. *Claims 1, 9, 12, 15 and 21 are patentable over Chu in view of Ma because Chu does not disclose plasma generated by exciting a fluorine-free carbon-containing gas*

Claims 1, 9, and 15 recite, *inter alia*, treating the photoresist pattern comprising an ArF photoresist material with plasma generated by exciting a fluorine-free carbon-containing gas. Claim 12 recites, *inter alia*, forming a polymer layer comprising carbon on the surface of the photoresist pattern comprising an ArF photoresist material using plasma generated by exciting a fluorine-free carbon-containing gas. Claim 21 recites, *inter alia*, forming a polymer layer using plasma generated by exciting a fluorine-free carbon-containing gas, the polymer layer comprising carbon on the surface of the photoresist pattern comprising an ArF photoresist material.

As such, in the present application, an ArF photoresist pattern is treated with plasma generated by a fluorine-free carbon-containing gas. Carbon radicals from the plasma generate a polymer layer on the ArF photoresist pattern. The polymer layer formed substantially of carbon covers the photoresist pattern and protects the photoresist pattern from deformation during a subsequent etching process using plasma containing fluorine radicals. The deformation occurs because the fluorine radicals in the subsequent etching process may eat away the ArF photoresist pattern. Accordingly, due to the polymer layer formed substantially of carbon radicals, the ArF photoresist pattern can be protected.

In the Final Office Action, the Examiner asserted that Chu discloses treating the photoresist pattern with plasma generated by exciting a fluorine-free carbon-containing gas, and

the Examiner asserted that the photoresist pattern of Chu can be replaced with ArF photoresist pattern of Ma.

However, Appellants respectfully submit that Chu does not disclose plasma generated by exciting a fluorine-free carbon-containing gas. In contrast, Chu discloses that the photoresist is treated with a carbon monoxide (CO) containing plasma. The CO containing gas plasma of Chu is different from a fluorine-free carbon-containing gas plasma because the CO containing gas plasma can still include fluorine. One of ordinary skill in the art understands that CO can be used, for example, in combination with CH_2F_2 and C_4F_8 . As such, the CO containing gas of Chu is not the same as fluorine-free carbon containing gas of the claimed embodiment.

- b. *Claims 1, 9, 12, 15 and 21 are patentable over Chu in view of Ma because Ma teaches away from using an ArF photoresist material in connection with treating a photoresist pattern by exciting a carbon-containing gas as described in Chu*

The Examiner fails to show proper motivation for modifying Chu to include an ArF photoresist of Ma. In contrast, Ma teaches away from using an ArF photoresist material in connection with treating a photoresist pattern by exciting a carbon-containing gas as described in Chu. This is because in Ma the photoresist materials including the ArF photoresist material are treated by a heat process such as curing or annealing. For example, Ma states that “it is yet another object of the present invention to provide a method for forming via openings or contact holes that have improved aspect ratios by first exposing the photoresist to UV radiation for a time period of at least 1 minute at a temperature of at least 100°C.” See col. 3, lines 28-32 of Ma. The art that the curing process applied to the ArF photoresist material taught by Ma is a different

type of photoresist pretreatment compared to the plasma treatment by exciting a carbon-containing gas taught by Chu, because such a heat treatment of Ma takes longer and should be performed in separate chambers. Therefore, unlike the Examiner's assertion, one of ordinary skill in the art would not be led to replace the photoresist material of Chu with the ArF photoresist material of Ma.

Therefore, Appellants respectfully submit that the embodiments of the invention as defined in claims 1, 9, 12, 15 and 21 are patentable and nonobvious over Chu in view of Ma. In addition, for at least the reason that claims 2, 5, 6, 10, 13, 16, 17 and 23 depend from claims 1, 9, 12, 15 and 21, respectively, these dependent claims are also submitted to be patentably distinct over the cited references.

- c. *Claims 1 and 17 are patentable over Chu in view of Ma because Chu does not disclose or suggest an etching target layer formed of a material selected from a group consisting of a silicon oxide layer, a silicon nitride layer, a silicon oxynitride layer, and an organic anti-reflective coating layer.*

Claims 1 and 17 are allowable for additional reasons. For example, Chu does not disclose or suggest an etching target layer formed of a material layer selected from a group consisting of a silicon oxide layer, a silicon nitride layer, a silicon oxynitride layer, and an organic anti-reflective coating layer. The Examiner maintains that "Chu discloses that one of the layers under the photoresist that is etched is a silicon oxynitride layer (paragraph 0020)." See the Advisory Action. However, the cited portion of Chu discloses that an etch stop layer (26), not an etching target layer (25), is formed of a silicon oxynitride layer. In contrast, Chu discloses that the etching target layer (25) includes organo silicate glass (OSG), C-oxide, and fluorinated silicate glass (FSG).

As such, Appellants request that the Board reverse the Examiner's rejection of claims 1, 2, 5, 6, 9, 10, 12, 13, 15-17, 21 and 23 under 35 U.S.C. §103(a).

Appellants respectfully submit that claims 1, 2, 5-10, 12, 13, 15-17, 19-21 and 23 stand rejected under 35 U.S.C. § 103(a) are patentable over Lindley (US 6,326,307) in view of Meyer (US 4,504,574) and Ma. For the reasons set forth below, Appellants respectfully request that the claim rejections under 35 U.S.C. § 103 be reversed.

2. Rejection of claims 1, 2, 5-10, 12, 13, 15-17, 19-21 and 23 under 35 U.S.C. §103(a) as being unpatentable over Lindley in view of Meyer and Ma

- a. *Claims 1, 9, 12, 15 and 21 are patentable over Lindley in view of Meyer and Ma because Meyer does not disclose that the carbon monoxide plasma is a fluorine-free carbon-containing gas*

Claims 1, 9, and 15 recite, *inter alia*, treating the photoresist pattern comprising an ArF photoresist material with plasma generated by exciting a fluorine-free carbon-containing gas. Claim 12 recites, *inter alia*, forming a polymer layer comprising carbon on the surface of the photoresist pattern comprising an ArF photoresist material using plasma generated by exciting a fluorine-free carbon-containing gas. Claim 21 recites, *inter alia*, forming a polymer layer using plasma generated by exciting a fluorine-free carbon-containing gas, the polymer layer comprising carbon on the surface of the photoresist pattern comprising an ArF photoresist material.

In the Final Office Action, the Examiner acknowledges that Lindley fails to disclose the photoresist treatment using a fluorine-free carbon-containing gas and acknowledges that Lindley fails to disclose an ArF photoresist material is used. The Examiner relies on Meyer to disclose the use of a fluorine-free carbon-containing gas, and relies on Ma to disclose the use of an ArF

photoresist.

Although Meyer discloses a carbon monoxide (CO) plasma, Meyer does not disclose that the carbon monoxide plasma is a fluorine-free carbon-containing gas. Even assuming, *arguendo*, that the CO plasma is a fluorine-free plasma, one of ordinary skill in the art would not modify a fluorine contained plasma of Lindley to include a fluorine free plasma of Meyer, because Lindley requires using fluorine contained plasma. For example, Lindley states that “the pretreatment includes difluoromethane (CH₂F₂), and its presence or that of a similar hydrofluorocarbon is considered crucial for this embodiment”. See col. 8, lines 42-45 of Lindley.

- b. *Claims 1, 9, 12, 15 and 21 are patentable over Lindley in view of Meyer and Ma because Ma teaches away from using an ArF photoresist material in connection with treating a photoresist pattern by plasma as described in Lindley*

Ma teaches away from using an ArF photoresist material in connection with treating a photoresist pattern by plasma as described in Lindley. This is because in Ma the photoresist materials including the ArF photoresist material are treated by a heat process such as curing or annealing. In contrast, Lindley describes that a heat treatment such as annealing is a different type of photoresist pretreatment from the plasma treatment performed by exciting a fluorine-free carbon-containing gas in Lindley, because such a heat treatment takes longer and should be performed in separate chambers. See e.g., col. 10, lines 2-4 of Lindley.

Therefore, Appellants respectfully submit that the embodiments of the invention as defined in claims 1, 9, 12, 15 and 21 are patentable and nonobvious over Lindley in view of Meyer and Ma. In addition, for at least the reason that claims 2, 5-8, 10, 13, 16, 17, 19, 20 and 23 depend from

claims 1, 9, 12, 15 and 21, respectively, these dependent claims are also submitted to be patentably distinct over the cited references.

As such, Appellants request that the Board reverse the Examiner's rejection of claims 1, 2, 5-10, 12, 13, 15-17, 19-21 and 23 under 35 U.S.C. §103(a).

Claims 3, 11, 14 and 24 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Lindley (US 6326307) in view of Meyer (US 4504574) and Ma (US 6830877) and further in view of Ko (US 2003/0129816).

**3. Rejection of claims 3, 11, 14 and 24 under 35 U.S.C. §103(a)
 as being unpatentable over Lindley in view of Meyer and Ma and
 further in view of Ko**

a. Claims 3, 11, 14 and 24 are patentable over Lindley in view of Meyer and Ma and further in view of Ko because these dependent claims depend from claims 1, 9, 12 and 21, respectively

Appellants respectfully submit that claims 3, 11, 14 and 24 are patentable over Lindley in view of Meyer and Ma and further in view of Ko, for at least the reason that claims 3, 11, 14 and 24 depend from claims 1, 9, 12 and 21 respectively, claims 3, 11, 14 and 24 are also submitted to be patentable over Lindley in view of Meyer and Ma and further in view of Ko.

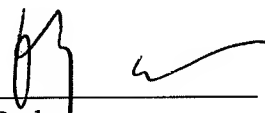
For the foregoing reasons, Appellants request that the Board reverse the Examiner's rejection of claims 3, 11, 14 and 24 under 35 U.S.C. §103(a).

B. CONCLUSION

Accordingly, for at least the reasons set forth above, claims 1-3, 5-17, 19-21, 23 and 24 are allowable.

Therefore, it is respectfully requested that the Board reverse all claim rejections under 35 U.S.C. § 103(a).

Respectfully submitted,



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CLAIMS APPENDIX

1. An etching method comprising:

preparing a photoresist pattern comprising an ArF photoresist material;

treating the photoresist pattern comprising an ArF photoresist material with plasma generated by exciting a fluorine-free carbon-containing gas; and

selectively etching an etching target layer by using the plasma-treated photoresist pattern as an etch mask,

wherein the etching target layer is formed of a material layer selected from a group consisting of a silicon oxide layer, a silicon nitride layer, a silicon oxynitride layer, and an organic anti-reflective coating layer.
2. The method of claim 1, further comprising generating the plasma by exciting carbon monoxide.
3. The method of claim 1, further comprising generating the plasma by exciting carbon dioxide.
5. The method of claim 1, wherein the etching of the etching target layer is performed using plasma containing fluorine radicals.
6. The method of claim 1, wherein the etching of the etching target layer is performed using plasma generated by exciting a fluorocarbon gas.

7. The method of claim 1, wherein the etching of the etching target layer is performed in a same reaction chamber as the plasma treatment without breaking vacuum.

8. The method of claim 7, wherein the etching of the etching target layer is performed by applying an RF bias power to a rear surface of the etching target layer, and the plasma treatment is performed by applying no RF bias power or applying a lower RF bias power than the RF bias power applied during the etching of the etching target layer.

9. An etching method comprising:

preparing a photoresist pattern comprising an ArF photoresist material;

treating the photoresist pattern comprising an ArF photoresist material with plasma generated by exciting a fluorine-free carbon-containing gas; and

selectively etching an etching target layer by using the plasma-treated photoresist pattern as an etch mask,

wherein the etching of the etching target layer is performed using plasma generated by exciting a fluorocarbon gas.

10. The method of claim 9, further comprising generating the plasma by exciting carbon monoxide.

11. The method of claim 9, further comprising generating the plasma by exciting carbon

dioxide.

12. An etching method comprising:

preparing a photoresist pattern comprising an ArF photoresist material;

forming a polymer layer comprising carbon on the surface of the photoresist pattern comprising an ArF photoresist material using plasma generated by exciting a fluorine-free carbon-containing gas; and

selectively etching an etching target layer using as an etch mask the photoresist pattern on which the polymer layer is formed,

wherein the etching of the etching target layer is performed using plasma generated by exciting a fluorocarbon gas.

13. The method of claim 12, wherein the plasma is generated by exciting carbon monoxide.

14. The method of claim 12, wherein the plasma is generated by exciting carbon dioxide.

15. An etching method comprising:

preparing a photoresist pattern comprising an ArF photoresist material by optical lithography using an ArF light source;

treating the photoresist pattern comprising an ArF photoresist material with plasma generated by exciting a fluorine-free carbon-containing gas;

selectively etching an etching target layer by using the plasma-treated photoresist pattern as

an etch mask; and

removing the remaining photoresist pattern by ashing,

wherein the etching of the etching target layer is performed using plasma containing fluorine radicals.

16. The method of claim 15, wherein the plasma is generated by exciting carbon monoxide.

17. The method of claim 15, wherein the etching target layer is formed of a material layer selected from a group consisting of a silicon oxide layer, a silicon nitride layer, a silicon oxynitride layer, and an organic anti-reflective coating layer.

19. The method of claim 15, wherein the etching of the etching target layer is performed in a same reaction chamber as the plasma treatment without breaking vacuum.

20. The method of claim 19, wherein the etching of the etching target layer is performed by applying an RF bias power to a rear surface of the etching target layer, and the plasma treatment is performed by applying no RF bias power or applying a lower RF bias power than the RF bias power applied during the etching of the etching target layer.

21. An etching method comprising:

preparing a photoresist pattern comprising an ArF photoresist material;

forming a polymer layer using plasma generated by exciting a fluorine-free

carbon-containing gas, the polymer layer comprising carbon on the surface of the photoresist pattern comprising an ArF photoresist material; and

selectively etching an etching target layer by using the photoresist pattern on which the polymer layer is formed as an etch mask,

wherein the etching of the etching target layer is performed using plasma generated by exciting a fluorocarbon gas.

23. The method of claim 22, further comprising generating the plasma by exciting carbon monoxide.

24. The method of claim 22, further comprising generating the plasma by exciting carbon dioxide.

EVIDENCE APPENDIX

There is no evidence submitted pursuant to 37 C.F.R. §§ 1.130, 1.131 or 1.132 or any other evidence entered by the Examiner and relied upon by Appellant in this Appeal.

RELATED PROCEEDINGS APPENDIX

None.